

Laparoscopic Inguinal Herniorrhaphy

Results of a Multicenter Trial

Robert J. Fitzgibbons, Jr., M.D., F.A.C.S., José Camps, M.D., Douglas A. Cornet, M.S.,
Nam X. Nguyen, M.D., Bradley S. Litke, M.D., Riccardo Annibali, M.D.,
and Giovanni M. Salerno, M.D.

From the Department of Surgery, Creighton University, School of Medicine, Omaha, Nebraska

Objective

The purpose of this study was to determine if laparoscopic inguinal herniorrhaphy represents a viable alternative to the conventional repair and to assess whether a prospective randomized controlled trial comparing both procedures is warranted.

Methods

Three types of laparoscopic inguinal herniorrhaphies (transabdominal preperitoneal [TAPP], intraperitoneal onlay mesh [IPOM], and totally extraperitoneal [EXTRA]) were studied in a phase II design. Twenty-one investigators from 19 institutions participated. Approval from the local human research committee was required at each institution before patients could be enrolled.

Results

There were 686 patients with 869 hernias; 366 (42.1%) were direct, 414 (47.6%) were indirect, 22 (2.5%) were femoral, and 67 (7.7%) were combination hernias. The TAPP procedure was used for 562 hernias, the IPOM was used for 217 hernias, and the EXTRA was used for 87 hernias. Sixty-one patients had additional abdominal procedures performed at the time of laparoscopy without any adverse effects on their herniorrhaphies. The overall recurrence rate was 4.5%, with a minimum follow-up of 15 months.

Complications were divided into the following three groups: 1) those related to laparoscopy, 2) those related to the patient, and 3) those related to the herniorrhaphy. Complications related to the laparoscopy occurred in 5.4% of patients; bleeding or abdominal wall hematomas occurred 31 times, (two patients required transfusion); one patient had bowel perforation, which was sutured laparoscopically; a bladder injury required laparotomy for management. Patient complications occurred in 6.7%. The majority involved the urinary tract (5.8%). Two patients required secondary abdominal procedures for adhesions, one for pain in the right lower quadrant and the other for adhesive small bowel obstruction. Postoperative myocardial infarction on day 5 resulted in the only operative mortality, for a rate of 0.1%. Complications related to the herniorrhaphy itself occurred in 17.1%. Most of these were minor, consisting of transient groin pain (3.5%), seroma (3.5%), transient leg pain (3.3%), hematoma (1.5%), or transient cord or testicular problems (0.9%). The incidence of leg pain decreased dramatically as surgeons became more familiar with the anatomy of the nerve supply to the groin when viewed laparoscopically. Ninety-three percent of patients were discharged within 24 hours of their operations.

Conclusions

Laparoscopic inguinal herniorrhaphy is an effective method to correct an inguinal hernia. It can be offered safely to patients undergoing other abdominal procedures. The TAPP, IPOM, and EXTRA

procedures appear to be equally effective. A controlled randomized trial is needed to compare this procedure with conventional inguinal herniorrhaphy.

The successful introduction of laparoscopic guidance as an aid to cholecystectomy has resulted in an intense effort to apply the technology to other operative procedures.^{1,2} Laparoscopic inguinal herniorrhaphy is one such procedure and probably is the most controversial.³⁻⁸

The purpose of this study was to determine if laparoscopic inguinal herniorrhaphy represents a viable alternative to the conventional repair. It was designed as a phase II trial⁹ to assess whether a prospective randomized controlled trial comparing laparoscopic inguinal herniorrhaphy with conventional inguinal herniorrhaphy is warranted.

STUDY DESIGN

Twenty-one principal investigators from 19 institutions participated. Investigators were distributed evenly between university and private practice settings (Table 1). The study began on April 9, 1991, and patient entry was completed on October 15, 1992, for a minimum follow-up of more than 1 year. A preliminary laboratory session was conducted with all principal investigators to standardize laparoscopic techniques and be certain that a representative from each institution was thoroughly familiar with the protocol. In some of the institutions, the laparoscopic herniorrhaphies were performed by associate surgeons under the supervision of the principal investigator. Approval from the local human research committee was required at each institution before patients could be enrolled.

The exclusion criteria for patient selection were as follows:

1. Younger than 12 years of age;
2. Pregnancy;
3. Severe obesity;
4. Associated medical problems that contraindicated safe induction of general anesthesia or elective surgery;
5. Subjects with signs of peritonitis, bowel obstruction, strangulation, or perforation;
6. Presence of infection, local or diffuse (i.e., urine, skin, sepsis, lung);

7. Subjects with depressive neurosis or psychotic reaction; and
8. Any other condition which, in the opinion of the investigators, would make the subject unsuitable for enrollment.

Three types of laparoscopic inguinal herniorrhaphies¹⁰⁻¹² were performed by the various investigators at their discretion. They were:

1. The transabdominal preperitoneal laparoscopic inguinal herniorrhaphy (TAPP). A diagnostic laparoscopy was performed and the hernia was identified from an intra-abdominal perspective. The peritoneum then was incised transversely above the hernia defect, and a complete dissection of the preperitoneal space was accomplished using instruments placed intra-abdominally via accessory ports. During the course of the preperitoneal dissection, direct sacs were reduced and indirect sacs were either dissected from the cord structures and reduced or divided circumferentially at the internal ring, leaving the distal sac in place. An appropriately sized polypropylene mesh prosthesis was placed in the preperitoneal space over the hernia defect, overlapping it widely. The prosthesis was either slit to accommodate the cord structures or sim-

Table 1. MULTICENTER HERNIA PROJECT INVESTIGATORS

Robert J. Fitzgibbons, Jr.	Creighton University
Namir Katkhouda	University de Nice
J. Barry McKernan	Marrieta, Georgia
Bruce Steffes	Fayetteville, North Carolina
Irwin Goldberg	Redondo Beach, California
Marvin Wexler	McGill University
Jeffery Peters	University of Southern California
Nathaniel Soper	Washington University
David Rose	Bryn Mawr, Pennsylvania
T. Lee Nigro	Kansas City, Missouri
Charles J. Filipi	Creighton University
Michael Bryant	Fayetteville, North Carolina
David Edelman	Miami, Florida
Richard Schlinkert	Mayo Clinic, Scottsdale
Bruce MacFadyen, Jr.	University of Texas, Houston
Jeffery Ponsky	Case Western University
Quan-Yang Duh	University of California, San Francisco
David Rattner	Harvard University
Lawrence Drahota	Kansas City, Missouri
Barry Salky	Mount Sinai, New York
Francisco Badosa	Albert Einstein University

Supported in part by grants from the Health Future Foundations, Omaha, Nebraska, and Ethicon, Inc., Cincinnati, Ohio.

Address reprint requests to Robert J. Fitzgibbons, Jr., M.D., F.A.C.S., Creighton University, School of Medicine, Department of Surgery, 601 North 30th Street, Omaha, NE 68131.

Accepted for publication February 23, 1994.

Table 2. SCALE FOR SIZE OF HERNIA

Hernia not detected preoperatively
Difficult to palpate
Easy to palpate; no bulge
Bulge only when straining
Visible bulge when standing (does not extend to scrotum)
Scrotal

ply placed over them according to surgeon preference. Finally, the polypropylene prosthesis was stapled in place using the following landmarks: the symphysis pubis medially, transversalis fascia above the internal ring superiorly, an arbitrary point approximately 1 cm medial to the anterior superior iliac spine laterally, the iliopubic tract inferolaterally, and Cooper's ligament inferomedially. The peritoneum was closed over the prosthesis using either staples or sutures to keep the mesh from coming in contact with intra-abdominal viscera.

2. The intraperitoneal onlay mesh laparoscopic herniorrhaphy (IPOM). A diagnostic laparoscopy was performed in an identical fashion as described for the TAPP procedure. The preperitoneal space was not entered but rather, a polypropylene mesh prosthesis was placed directly onto the peritoneum overlapping the hernia defect widely. The hernia sac was left in place. The prosthesis was stapled us-

ing the same landmarks as described with the TAPP procedure.

3. The totally extraperitoneal laparoscopic herniorrhaphy (EXTRA). The skin and fascia at the umbilicus were incised using an open laparoscopic technique, but the peritoneum was left intact. Dissection was then begun in the preperitoneal space beginning at the umbilicus and continuing inferiorly, allowing the surgeon to establish a "pneumoextraperitoneum" using CO₂ gas. Once the space was enlarged sufficiently, additional ports were placed into the extraperitoneal space so that laparoscopic instrumentation could be introduced. The abdominal cavity was not entered intentionally during the procedure. Dissection proceeded until the area of the hernia defect was encountered and the procedure continued in an identical fashion to the aforementioned TAPP operation.

RESULTS

There were 686 patients with 869 hernias. Four-hundred twenty-five hernias were on the left and 444 on the right. One-hundred eighty-three patients (26.7%) had bilateral hernias. One-hundred twenty-six hernias (14.5%) were recurrent at the time of enrollment. Thirty-seven (4.2%) of the hernias were sliding inguinal hernias. The patients ranged in age from 13 to 87 years, with a mean age of 49 years.

The size of the hernia was determined preoperatively

Figure 1. Type of repair vs. size of hernia.

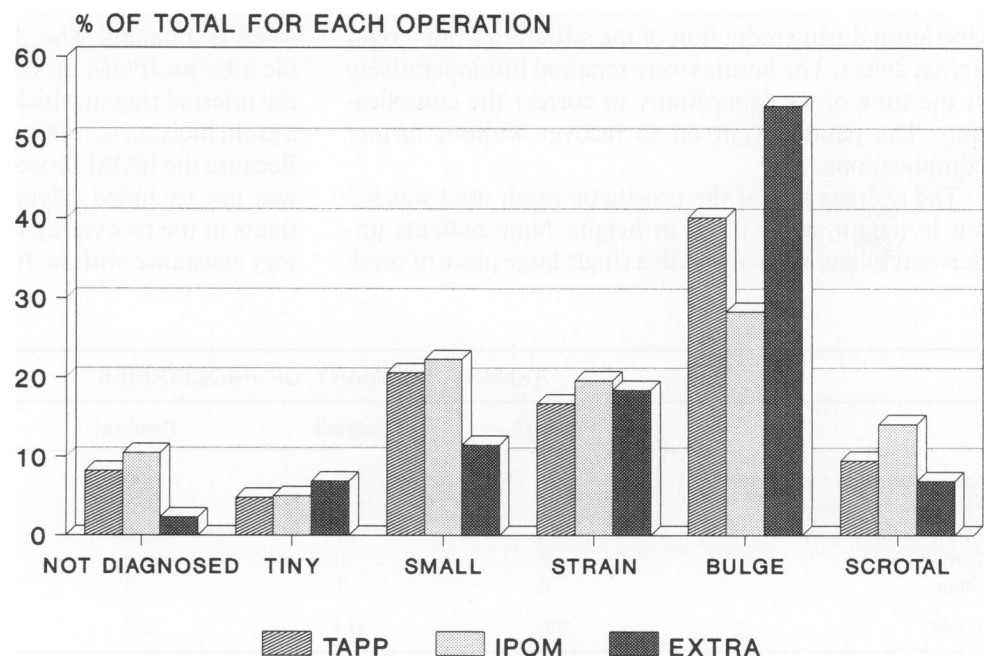


Table 3. ADDITIONAL ABDOMINAL PROCEDURES

Procedure	No.
Umbilical herniorrhaphy	17
Lysis adhesions	11
Cholecystectomy	7
Gynecologic procedure	6
Vasectomy	5
Varicocele ligation	4
Liver biopsy	4
Lymph node biopsy	2
Orchiectomy (undescended testicle)	2
Ventral herniorrhaphy	1
Meckel's diverticulectomy	1
Resection infarcted appendix epiploica	1
Total	61

according to Table 2. No significant difference between the size of the hernia and the type of laparoscopic inguinal herniorrhaphy chosen by the investigator was demonstrated (Fig. 1).

In sixty-one patients (8.9%), additional abdominal procedures were accomplished at the time of herniorrhaphy. These procedures are shown in Table 3.

There were 414 (47.7%) indirect hernias, 366 (42.1%) direct hernias, 67 (7.7%) combined hernias, and 22 (2.5%) femoral hernias. The type of laparoscopic inguinal herniorrhaphy performed in relation to the type of inguinal hernia is shown in Table 4. The laparoscopic inguinal herniorrhaphy was not completed in one patient (0.1%) with two hernias (0.2%). This patient (who had bilateral direct inguinal hernias) sustained a bladder laceration during reduction of the structure from a right hernia defect. The hernias were repaired intraoperatively at the time of the laparotomy to correct the complication. The patient went on to recover without further complications.

The average size of the prosthetic mesh used was 9.2 cm in length and 6.0 cm in height. Nine patients underwent bilateral repairs with a single large piece of mesh

that averaged 18.8 cm in length and 6.9 cm in height. The average number of staples used to secure the mesh was 15, with a range of 4 to 52. The mean number of staples used to close the peritoneum for the TAPP procedure was 7.51, with a range of 1 (using suture to complete the closure in this case) to 24.

The mean operating time for unilateral repair was 70 minutes. For bilateral repairs, the mean operating time was 90.6 minutes.

Ninety-three percent of patients were discharged from the hospital within the first 24 postoperative hours (Fig. 2). Most patients staying more than 1 day did so because of the development of a complication or because of comorbid conditions. The average length of hospital stay was not significantly different among the three operative procedures.

COMPLICATIONS

Complications were arbitrarily divided into the following three groups: 1) those related to laparoscopy, 2) those related to the patient, and 3) those related to the herniorrhaphy. The determination that a complication had developed was the responsibility of the investigator surgeon.

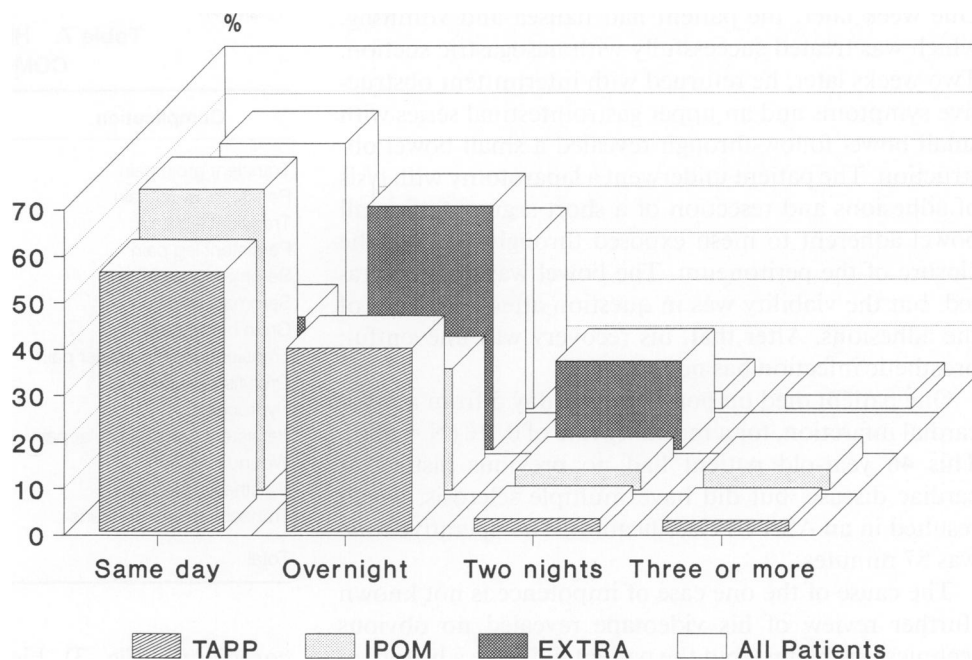
Laparoscopic Complications

Complications of laparoscopy (Table 5) included 24 episodes of bleeding (2 requiring transfusion), eight abdominal wall hematomas, one bowel perforation caused by a grasper and repaired laparoscopically, and the aforementioned bladder injury. Included in the bleeding episodes is a patient who developed bleeding of the distal sac after an IPOM procedure with division of the sac at the internal ring in which the surgeon elected to perform a groin incision to remove the sac to control the bleeding. Because the IPOM procedure was completed, the patient was not excluded. Hypercapnia was noted in two patients in the recovering room who responded to ventilatory assistance with no further sequela.

Table 4. SUMMARY OF PROCEDURES

	Direct	Indirect	Femoral	Combined	Totals
Transabdominal preperitoneal	297	196	20	49	562
Intraperitoneal onlay mesh	21	186	2	8	217
Totally extraperitoneal	46	31	0	10	87
Conversion	2	0	0	0	2
Other	0	1	0	0	1
Totals	366	414	22	67	869

Figure 2. Postoperative hospital stay.



The investigators reported 13 cases of various equipment malfunctions, technical difficulties related to either dissection or adhesions, or other similar findings. All were corrected successfully and none necessitated the need for abandonment of the laparoscopic herniorrhaphy and conversion to an open procedure. These were not considered laparoscopic complications, merely difficulties.

Patient Complications

Patient complications are listed in Table 6. Urinary difficulties (5.8%) included dysfunction, retention, or infection. The four patients with a prolonged ileus responded to conservative management with nasogastric suction. One patient developed an aspiration pneumonia.

Two patients with adhesions required operative intervention. The first patient underwent a left IPOM and a right TAPP procedure for bilateral recurrent hernias (three previous repairs on right and one on left). The right inferior epigastric vessels were ligated because of bleeding. The patient did well initially, but 6 months later, had severe right lower quadrant abdominal pain. A second laparoscopy was performed, and the patient was found to have adhesions between the small bowel and the peritoneal closure on the right, without evidence of bowel obstruction. The left IPOM polypropylene mesh was intact, with no adhesions observed. The adhesions were lysed, and the patient recovered without further sequelae. No recurrence of either hernia has been observed. The second patient initially underwent a TAPP procedure for a right indirect inguinal hernia. The repair was entirely uneventful, and the patient was discharged.

Table 5. LAPAROSCOPIC COMPLICATIONS

Complication	No. (N = 686)
Bleeding/no transfusion	22 (3.2%)
Bleeding/transfusion	2 (0.3%)
Abdominal wall hematoma	8 (1.2%)
Trocar site hernia	5 (0.7%)
Hypercapnia	2 (0.3%)
Bowel perforation	1 (0.1%)
Bladder injury	1 (0.1%)
Total	41 in 37 patients (5.4%)

Table 6. PATIENT COMPLICATIONS

Complication	No. (N = 686)
Urinary (retention/dysfunction)	40 (5.8%)
Ileus	4 (0.6%)
Aspiration pneumonia	1 (0.1%)
Right lower quadrant adhesions	1 (0.1%)
Adhesive small bowel obstruction	1 (0.1%)
Myocardial infarction	1 (0.1%)
Impotence	1 (0.1%)
Paralyzed diaphragm	1 (0.1%)
Total	50 in 46 patients (6.7%)

One week later, the patient had nausea and vomiting, which was treated successfully with nasogastric suction. Two weeks later, he returned with intermittent obstructive symptoms and an upper gastrointestinal series with small bowel follow-through revealed a small bowel obstruction. The patient underwent a laparotomy with lysis of adhesions and resection of a short segment of small bowel adherent to mesh exposed through a gap in the closure of the peritoneum. The bowel was not perforated, but the viability was in question after dissection of the adhesions. After that, his recovery was uneventful; prosthetic infection has not occurred.

One patient died on postoperative day 5 from a myocardial infarction, for a mortality rate of 0.1% (N = 686). This 46 year-old patient had no previous history of cardiac disease, but did have multiple sclerosis, which resulted in an ASA III classification. The operative time was 57 minutes.

The cause of the one case of impotence is not known (further review of his videotape revealed no obvious technical problems), but the patient did have a history of intermittent impotence preoperatively.

One patient experienced respiratory insufficiency in the recovery room and was noted on chest x-ray and fluoroscopy to have a paralyzed right diaphragm. The patient required intubation for 48 hours until the diaphragm recovered spontaneously. He was discharged from the hospital on the fifth postoperative day.

A single complication related to the additional abdominal procedures listed in Table 3 was reported. This was a staple line breakdown after resection of a Meckel's diverticulum discovered incidentally during the laparoscopy for bilateral herniorrhaphy. The patient required laparotomy on the second postoperative day to repair the leak. Recovery from the second procedure was uneventful. The prostheses were left in place, and there has been no infection of the mesh or recurrence of the hernias. This was not included in the table for patient complications because it was not a complication of the herniorrhaphy.

Herniorrhaphy Complications

Herniorrhaphy complications are listed in Table 7. The one patient converted to an open procedure (two hernias) was not included (therefore, N = 867).

Transient complications were defined arbitrarily as those that resolved within 2 months; persistent complications were those lasting longer than 2 months. Transient or persistent leg pain occurred frequently in the early part of the study. Interim analysis of the data had revealed this alarming incidence of apparent neuralgia, and an alert was forwarded to all investigators. This resulted in a precipitous decrease in the reports of these

Table 7. HERNIORRHAPHY COMPLICATIONS

Complication	No. (N = 867)
Transient groin pain	30 (3.5%)
Persistent groin pain	14 (1.6%)
Transient leg pain	29 (3.3%)
Persistent leg pain	11 (1.3%)
Seroma/no aspiration	21 (2.4%)
Seroma/aspiration	9 (1.0%)
Groin hematoma	13 (1.5%)
Transient cord/testicular pain	8 (0.9%)
Orchitis/epididymitis	8 (0.9%)
Hydrocele	8 (0.9%)
Persistent cord/testicular pain	5 (0.6%)
Wound infection	2 (0.2%)
Prosthesis infection	1 (0.1%)
Transection vas deferens	1 (0.1%)
Total	160 in 148 hernias (17.1%)

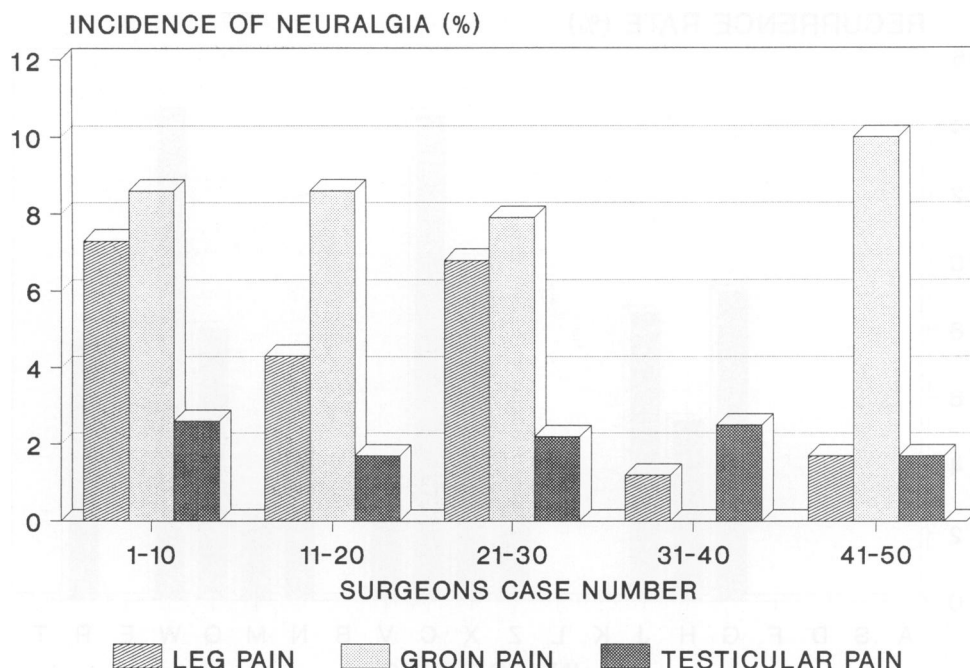
complaints (Fig. 3). Figure 3 depicts the incidence of groin and testicular pain. The results must be interpreted with the understanding that the assessment of groin pain was subjective, based on the perception by the investigator that the pain was more significant than usual. The incidence of testicular pain was low, but remained constant throughout the course of the study.

There was a higher incidence of neuralgia in patients undergoing the IPOM procedure (Fig. 4). All neuralgias eventually resolved spontaneously, with one exception. This latter patient required a secondary laparoscopy to remove an offending staple and currently is free of symptoms.

The incidence of cord and testicular complaints, seroma, and hematoma are shown in relationship to the type of procedure performed in Figure 4. The decision to aspirate a seroma was left entirely to the discretion of the investigator. The nine cases of orchitis/epididymitis resolved with conservative management.

Eighteen months postoperatively, the patient with the prosthesis infection had a fluctuant right groin mass (right-sided IPOM procedure). This mass was aspirated and contained enteric organisms. The abscess was drained, and the patient underwent repeat laparoscopy and was found to have an inflammatory mass involving the prosthesis and the cecum. The prosthetic material was removed easily because the inflammatory process caused it to become detached from the abdominal wall. A fecal fistula did not develop. The appendix could not be identified during the laparoscopy, and a barium enema performed 2 months later did not show visualization of the appendix. It is unknown whether this represented a secondary infection of the prosthesis caused by appendicitis or whether this represented cecal erosion by

Figure 3. Incidence of neuralgia in relationship to surgeon experience. Incidence of neuralgia decreased dramatically during the course of the study.



the prosthesis. Interestingly, the patient has been examined repeatedly for 1 year and has not developed evidence of a recurrent hernia.

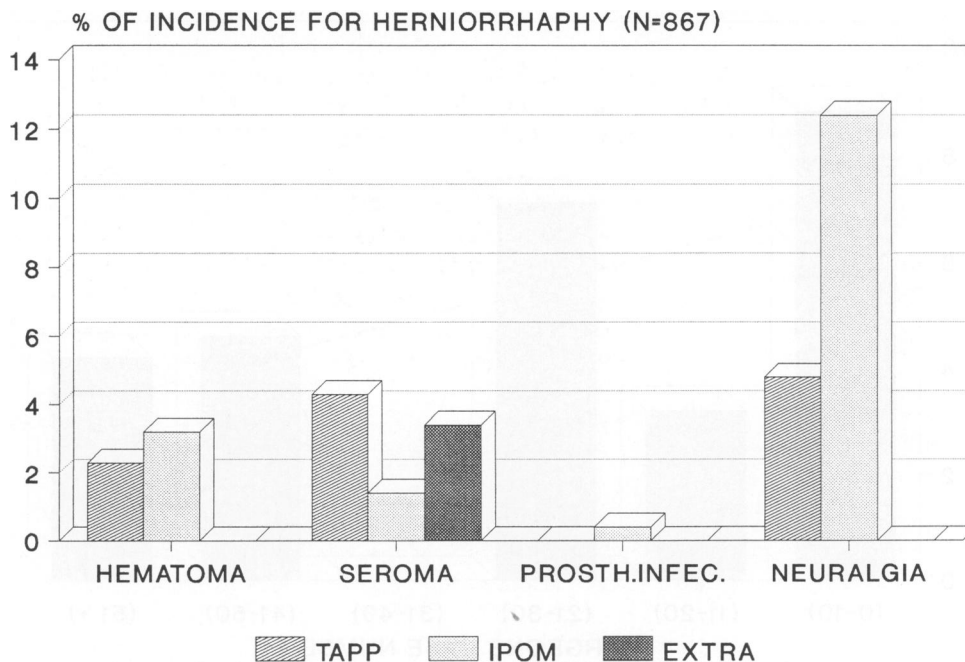
RECURRENCE RATE

Records concerning recurrences were maintained by each investigator. Long-term follow-up visits (approximately yearly) were conducted by the surgeon except

when logistic considerations mandated that the evaluation be performed by either a local physician or a telephone/mail survey.

There were 39 recurrences in 867 hernias repaired laparoscopically, for a recurrence rate of 4.5%. The mean follow-up was 23 months, with a range of 15 to 34 months. The recurrence rate was 5.0% ($n = 562$) for the TAPP procedure and 5.1% ($n = 217$) for the IPOM procedure. There were no recurrences for the EXTRA

Figure 4. Incidence of neuralgia, hematoma, seroma, and cord/testicular problems vs. the type of procedure performed.



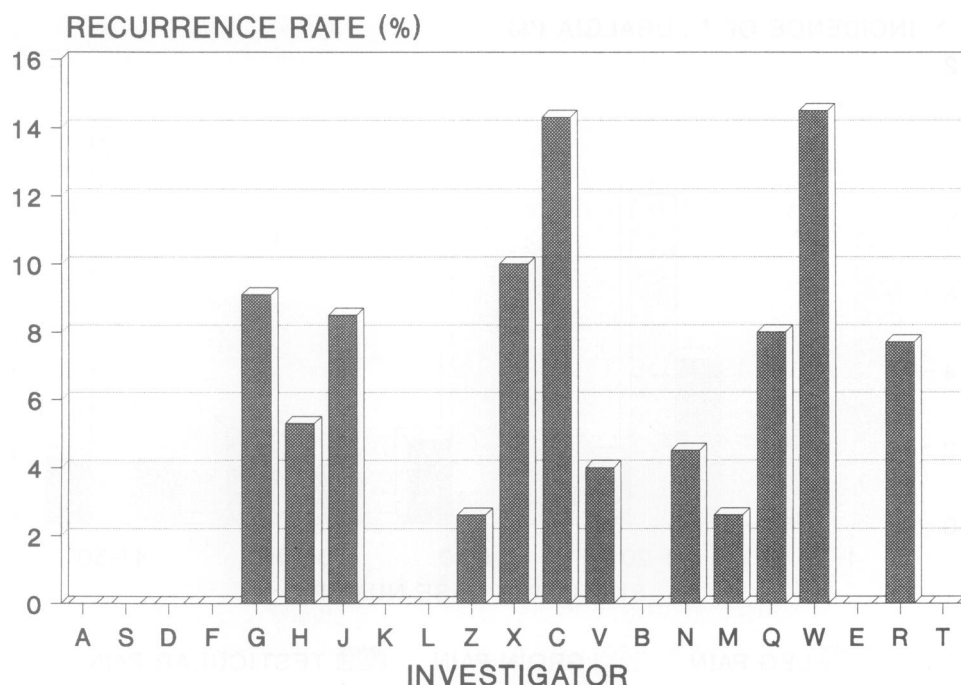


Figure 5. Recurrence rate vs. investigator.

repair ($n = 87$). Most of the EXTRA procedures were performed by a single investigator (J.B.M.). The two hernias in one patient that were not repaired laparoscopically were not included in the calculation of recurrence rate.

Recurrence rates for individual surgeons ranged from 0 to 14.5% (Fig. 5). Surgeon experience *versus* recurrence rate is shown in Figure 6. The recurrence rates were ana-

lyzed in relationship to the preoperative size and the type of the hernia. A significant difference was not appreciated (Fig. 7). Similarly, analysis of the size of the prosthesis *versus* the size of defect failed to show a correlation with recurrence rate. Of the 126 hernias that were recurrent at the time of enrollment, five further recurrences were reported. Thus, the recurrence rate in this subgroup of patients was 3.9%.

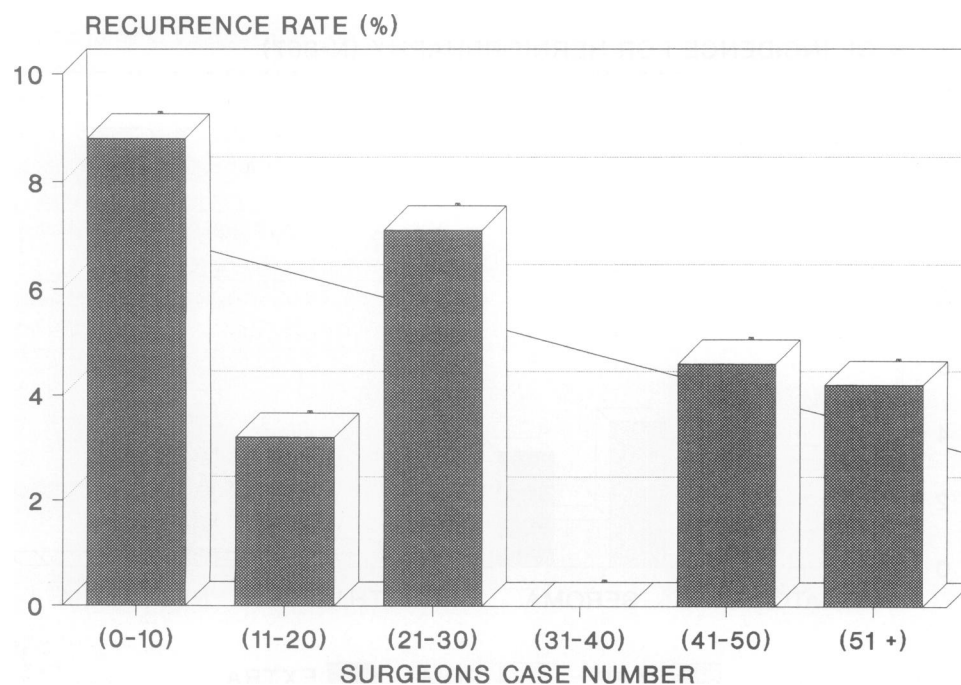
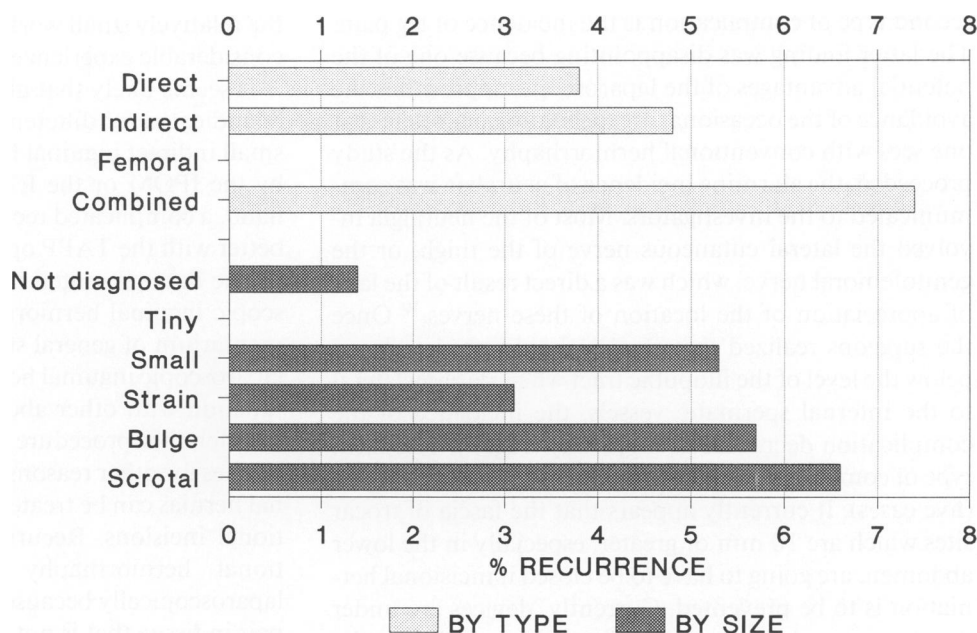


Figure 6. Recurrence rate vs. the number of cases improved as surgeons gained experience.

Figure 7. Recurrence rate vs. the size and type of hernia. The scale for the size of the hernia is found in Table 2.



DISCUSSION

The advantages and disadvantages of laparoscopic inguinal herniorrhaphy (LIHR) are currently a matter of considerable debate.

Laparoscopic inguinal herniorrhaphy has the following potential advantages: 1) less postoperative discomfort/pain, 2) reduced recovery time, allowing an earlier return to full activity, 3) easier repair of a recurrent hernia because the repair is performed in tissue that has not been dissected previously, 4) the ability to treat bilateral hernias, 5) the performance of a simultaneous diagnostic laparoscopy, 6) the highest possible ligation of the hernia sac, and 7) an improved cosmesis.¹⁰⁻¹⁴ The earlier return to full activity is an important socioeconomic factor because the decrease in time away from work could potentially offset the higher operative costs. Finally, it is theorized that LIHR might have a lower recurrence rate than conventional inguinal herniorrhaphy because of the mechanical advantage gained by placing the prosthesis in the preperitoneal space and the "tension free" nature of the repair.^{15,16}

The main arguments against LIHR are as follows: 1) conventional inguinal herniorrhaphy is an effective operation already performed as an outpatient procedure with low morbidity and mortality; 2) conventional inguinal herniorrhaphy may be performed under local anesthesia whereas LIHR usually requires general anesthesia; and 3) LIHR is more expensive.^{17,18} These questions could best be answered by a well-designed prospective randomized trial. The purpose of this study was to gather data to see if such a study is warranted.

The recurrence rate observed in this study of 4.5% with

a median follow-up of 21 months is encouraging. This rate must be considered in the light of the fact that the investigators were in the early part of the learning curve for LIHR. In fact, the highest recurrence rate was in the first ten herniorrhaphies for individual investigators. Laparoscopic inguinal herniorrhaphy is a relatively advanced laparoscopic procedure, and those performing it must be trained thoroughly and monitored by surgeons with experience. Recurrence rates should improve as experience is gained. The data presented in this paper provide strong evidence to support the contention that the laparoscopic approach is an effective way to treat an inguinal hernia. The major question then becomes whether the morbidity associated with an intra-abdominal approach to an inguinal hernia can be justified compared with the conventional completely extraperitoneal operation.

The overall incidence of complications was not dramatically different from what one might expect to see with a conventional inguinal herniorrhaphy series. However, three types of complications need to be emphasized because they are unique to the laparoscopic approach. The first type of complication is a potential for a secondary abdominal procedure. In this series, six patients (0.87%) ultimately required a second abdominal procedure—two laparotomies (one to correct the bladder laceration, and one for a delayed small bowel obstruction), and four laparoscopies (one for a patient with right lower quadrant abdominal pain believed to be related to adhesions; a second to remove an infected prosthesis; a third for excessive bleeding from a trocar site; and a fourth patient with persistent leg pain to remove a staple). The

second type of complication is the incidence of leg pain. The latter finding was disappointing because one of the potential advantages of the laparoscopic approach is the avoidance of the occasional incapacitating neuralgia that one sees with conventional herniorrhaphy. As the study proceeded, the alarming incidence of neuralgia was communicated to the investigators. Most of the neuralgia involved the lateral cutaneous nerve of the thigh, or the genitofemoral nerve, which was a direct result of the lack of appreciation of the location of these nerves.¹⁹ Once the surgeons realized that staples should not be placed below the level of the iliopectic tract when stapling lateral to the internal spermatic vessels, the incidence of the complication decreased dramatically (Fig. 3). The third type of complication is the problem of trocar site hernias (five cases). It currently appears that the fascia of trocar sites which are 10 mm or greater, especially in the lower abdomen, are going to have to be closed if incisional herniation is to be prevented. Currently, devices are under development which should facilitate closure of fascia despite the small skin incision.

Laparoscopic inguinal herniorrhaphy is an evolving technique that is not yet standardized. Once the best procedure or procedures becomes accepted, it is likely that the incidence of complications will decrease. This is underscored by the decrease in incidence of neuralgia during the course of the study. It remains to be seen whether the incidence will be low enough to justify the laparoscopic approach.

No obvious advantage of one type of laparoscopic inguinal hernia repair of the three studied in this trial could be demonstrated. The TAPP operation was the most frequently performed repair—which is consistent with the fact that it is the most widely accepted laparoscopic inguinal herniorrhaphy.¹⁰ The TAPP operation is appealing to many surgeons because it is essentially identical to the preperitoneal repairs popularized by Stoppa,²⁰ Nyhus,²¹ and others, except that the preperitoneal space is entered via a peritoneal incision instead of transcutaneously.

The second most popular procedure was the IPOM. This procedure is attractive because of its simplicity.¹¹ However, the possibility of erosion of an intra-abdominally placed prosthesis into intra-abdominal viscera remains distinct, and therefore, it must be considered an investigational operation. The development of a truly inert prosthesis could result in a wider acceptance of this operation.

The EXTRA procedure is felt by its proponents to be the best approach because the peritoneal cavity is not entered, and therefore, much of the feared morbidity related to laparoscopic herniorrhaphies is avoided. However, the procedure is technically more difficult because

the relatively small working space can be confusing until considerable experience is gained.

It seems likely that all three of these procedures may be indicated for different circumstances. For example, a small indirect inguinal hernia is treated particularly well by the IPOM or the EXTRA procedure. On the other hand, a complicated recurrent hernia can be approached better with the TAPP operation.

The data presented in this paper suggest that laparoscopic inguinal herniorrhaphy has a place in the armamentarium of general surgeons. Sixty patients had their laparoscopic inguinal herniorrhaphies performed in conjunction with other abdominal procedures. The ability to offer this procedure to patients undergoing laparoscopies for other reasons is an advantage. Bilateral inguinal hernias can be treated laparoscopically without additional incisions. Recurrences that occur after conventional herniorrhaphy can readily be approached laparoscopically because of the ability to perform the repair in tissue that is not dissected. The problem is that if laparoscopic inguinal herniorrhaphy is reserved for these selected circumstances, it is unlikely that an individual surgeon could gain enough experience to perform the procedure well when indicated.

The next step in the evaluation of laparoscopic inguinal herniorrhaphy must be a randomized prospective trial comparing it with conventional herniorrhaphy. The data in this paper suggest that such a trial is warranted. There are many variables that will make the design of such a trial difficult and expensive. These include surgeon expertise, type of laparoscopic procedure to study, type of conventional procedure to study, independent postoperative evaluation, interpretation variability, pain measurement, patient motivation to return to work, patient's compliance with adequate follow-up, and investigator motivation. Given the socioeconomic impact of an operation performed with such frequency as herniorrhaphy, such a trial seems justified despite these difficulties.

CONCLUSION

The results from this multicenter trial allow for the following conclusions: 1) laparoscopic inguinal herniorrhaphy is an effective method to correct an inguinal hernia; 2) the early failure rate is low, even with relatively inexperienced surgeons, 3) laparoscopic inguinal herniorrhaphy can be performed safely at the time of laparoscopy for other procedures, 4) the incidence of neuralgia is disturbing but decreasing as surgeons better appreciate the anatomy when viewed laparoscopically.

Laparoscopic herniorrhaphy will result in the need for a second abdominal procedure in a small (less than 1%) number of patients. It remains to be seen whether this

will be offset the potential benefit. A randomized prospective trial comparing laparoscopic inguinal herniorrhaphy with the conventional procedure is warranted.

References

1. Cuschieri A. The spectrum of laparoscopic surgery. *World J Surg* 1992; 16:1089-1097.
2. Zucker KA. Perceived future of laparoscopic surgery. *Can J Surg* 1992; 35:297-304.
3. Ger R, Monroe K, Duvier R, et al. Management of direct inguinal hernias by laparoscopic closure of the neck of the sac. *Am J Surg* 1990; 159:370-373.
4. Popp L. Improvement in endoscopic hernioplasty: transcutaneous aquadissection of musculofascial defect and preperitoneal endoscopic patch repair. *J Laparoendosc Surg* 1991; 1:83-90.
5. Schultz L, Graber J, Pietrafitta J, Hickok D. Laser laparoscopic herniorrhaphy: a clinical trial preliminary results. *J Laparoendosc Surg* 1990; 1:41-45.
6. Salerno GM, Fitzgibbons RJ Jr, Filipi CJ. Laparoscopic Inguinal Hernia Repair. In Zucker KA. *Surgical Laparoscopy*. St. Louis: Quality Medical Pub, 1990, pp 281-293.
7. Nyhus LM. Laparoscopic hernia repair: a point of view. *Arch Surg* 1992; 127:137.
8. Rutkow IM. Laparoscopic hernia repair. the socioeconomic tyranny of surgical technology. *Arch Surg* 1992; 127:1271.
9. Friedman LM, Furberg CD, DeMets DL. *Fundamentals of Clinical Trials*, 2nd ed. Littleton, MA: PSG Pub Co, 1985.
10. Filipi CJ, Fitzgibbons RJ Jr, Salerno GM, Hart RO. Laparoscopic herniorrhaphy. *Surg Clin North Am* 1992; 72:1109-1124.
11. Fitzgibbons RJ Jr, Salerno GM, Filipi CJ, et al. Laparoscopic intraperitoneal onlay mesh technique for the repair of an indirect inguinal hernia. *Ann Surg* 1994; 219:144-156.
12. McKernan JB, Laws HL. Laparoscopic repair of inguinal hernias using a totally extraperitoneal prosthetic approach. *Surg Endosc* 1993; 7:26-28.
13. Ger R, Mishrick A, Hurwitz J, et al. Management of groin hernias by laparoscopy. *World J Surg* 1993; 17:46-50.
14. Felix EL, Michas C. Double-buttress laparoscopic herniorrhaphy. *J Laparoendosc Surg* 1993; 3:1-8.
15. Conceptualization and Measurement of Physiological Health for Adults. Santa Monica, CA: Rand, 1983, pp 3-120.
16. Asmussen T, Jensen FU. A follow-up study on recurrence after inguinal hernia repair. *Surg Gynecol Obstet* 1983; 156:198-200.
17. Barnes FE. Cost-effective hernia repair. *Arch Surg* 1993; 128:600.
18. Lichtenstein IL, Shulman AG, Amid PK. Laparoscopic hernioplasty. *Arch Surg* 1991; 126:1449.
19. Spaw AT, Ennis BW, Spaw LP. Laparoscopic hernia repair: the anatomic basis. *J Laparoendosc Surg* 1991; 1:269-277.
20. Stoppa RE, Waralaumont CR. The preperitoneal approach and prosthetic repair of groin hernia. In Nyhus LM, Condon RE, eds. *Hernia*. Philadelphia, PA: JB Lippincott Co, 1989, pp 199-221.
21. Nyhus LM, Pollack R, Bombeck CT, Donahue PE. The preperitoneal approach and prosthetic buttress repair for recurrent hernia: the evolution of a technique. *Ann Surg* 1988; 208:733-737.